

Environmental Restoration

Groundwater at the NTS

Introduction

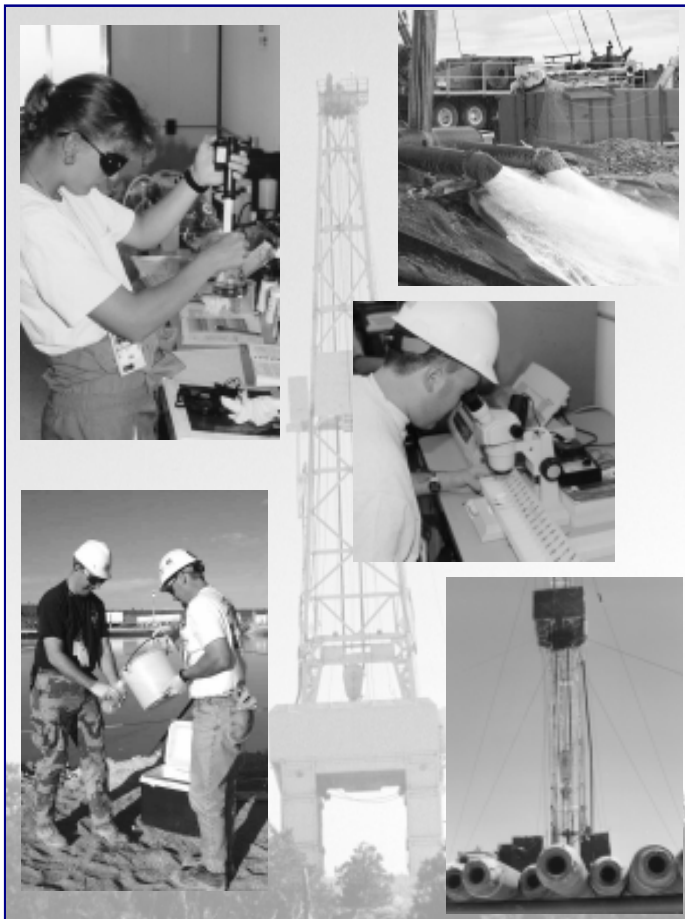
The Nevada Test Site (NTS), primary location for the nation's nuclear weapons testing program, is also the location of one of the federal government's most comprehensive groundwater study programs. The U.S. Department of Energy (DOE) began this intensive, long-term program with the purpose of maintaining safe groundwater conditions both at, and surrounding, the NTS. The aim of these groundwater studies has been to identify radiological risks (if, where, and when they exist) resulting from underground nuclear testing, predict groundwater movement, and define boundaries for safe water use.

As can be expected, developing strategies/programs that help scientists understand these complex, underground flow systems is an ongoing challenge: study areas are often large and geologically complex; and methods of data collection and interpretation are continuously evolving. But through the ongoing compilation of geologic and hydrologic information gathered from numerous wells, scientific studies, and state-of-the-art modeling software, experts are developing more reliable methods to ensure groundwater safety at the NTS.

Historical Perspective

Since the early 1950s, the 1,375-square mile Nevada Test Site, 65 miles northwest of Las Vegas, has served as host for many atmospheric and underground nuclear tests. These tests, plus related support activities and nuclear rocket experiments, have contaminated portions of the NTS. In 1989, the DOE Nevada Operations Office (DOE/NV) initiated an Environmental Restoration program to address concerns relating to this contamination. The program was designed to coordinate and carry out numerous cleanup activities, ranging from the removal of underground storage tanks to the remediation of plutonium-contaminated soils.

As part of this environmental restoration effort, researchers also set out to explore the effects of underground nuclear weapons testing on the groundwater at the NTS. In total, 908 detonations were conducted in shafts and tunnels at depths ranging from approximately 90 to 4,800 feet below the ground surface. About one-third of these tests occurred near or below the water table, resulting in contamination of the groundwater. Hydrologic research initiated in the 1970s was combined with the Environmental Restoration Program's current groundwater studies program to examine: groundwater flow rates and directions; the location, size, and, depth of aquifers; and other relevant information concerning the area's hydrology and geology.





The DOE's Strategy for Studying Groundwater

As mentioned earlier, the complex geology and hydrology of the Nevada Test Site present unusual challenges in understanding groundwater flow and the movement of contaminants. To meet these challenges, the NTS groundwater studies program, now known as the Underground Test Area, or UGTA Project, embarked on an investigative process that incorporates various research components, such as sampling technology, contaminant characterization, computer modeling, and process validation.

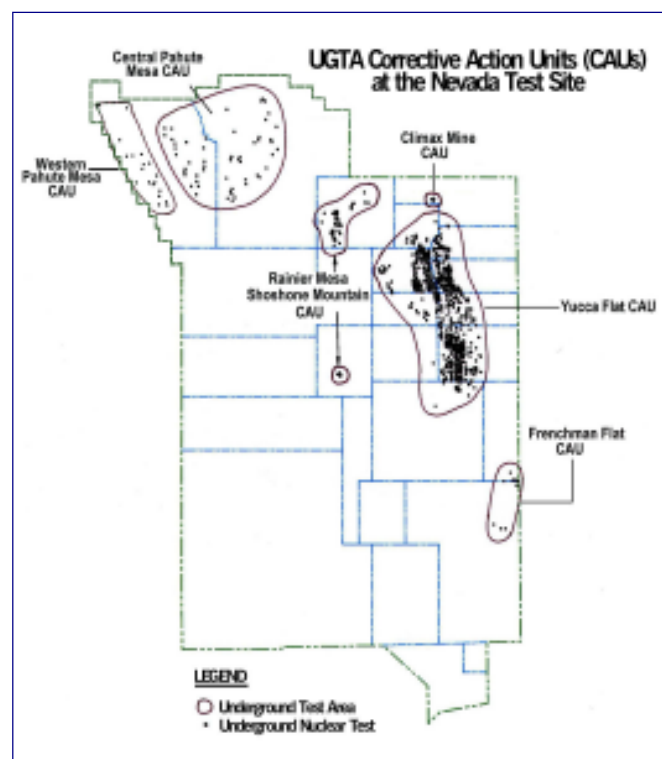
Utilizing these components, UGTA designed a phased strategy—the objective of which is to establish a sound monitoring network using new and existing wells. The first phase of the strategy consists of a regional evaluation, which explores the groundwater pathways over large areas both upgradient and downgradient from the underground nuclear testing locations. The second, local (site-specific), phase will help scientists identify contaminant movement and boundaries that are unique to each of the underground test areas (see map). It is important to note that, whenever possible, the UGTA Project supplements its data with hydrologic findings from: past weapons testing programs; the Desert Research Institute; the Lawrence Livermore and Los Alamos National Laboratories; the U.S. Geological Survey; the Yucca Mountain Site Characterization Project; and other State, Federal, and private sources.

Phase One (Regional Model)

The Phase One, or regional, approach was a large-scale investigation designed to determine the overall geologic and hydrologic attributes of the entire NTS and surrounding areas. This phase called for the drilling of wells at various, predetermined locations on the NTS, extracting rock and groundwater samples from the wells, comparing the results with historical data, and then preparing a model detailing the area's underlying geology. Based on the results of this geologic model, a regional groundwater flow and transport model was then formulated, providing scientists necessary information on the region's groundwater flow pattern and the potential off-site movement of the contaminant, tritium. Tritium is the main contaminant of concern because it is expected to be the most mobile radiological contaminant in the groundwater.

Phase Two (Local Models)

The Phase Two, or local, approach treats individual underground testing areas, rather than entire regions, as investigative units. The *Federal Facilities Agreement and Consent Order*, the regulatory framework under which UGTA operates, has grouped underground test areas into six geographically-distinct units: (1) Frenchman Flat, (2) Western Pahute Mesa, (3) Yucca Flat, (4) Central Pahute Mesa, (5) Climax Mine, and (6) Rainier Mesa/Shoshone Mountain. For these individual test areas, or *Corrective Action Units (CAUs)*, scientists determine whether sufficient geologic, hydrologic, and geochemical data exist to construct more focused, small-scale hydrogeologic models. If there is enough data, scientists will develop a *local* groundwater flow and transport model. If further data is needed, UGTA specialists must devise a new plan for data collection, which typically calls for the drilling of additional wells. Modeling in Phase Two not only takes into account the movement of tritium in groundwater, but also looks at other possible contaminants.





What is a Contaminant Boundary?

UGTA scientists will use the results of the models to establish a boundary that defines where water *is* and is *not* safe for domestic or municipal use. The boundary between safe and unsafe water is called the *contaminant boundary*. Boundary calculations are based upon predictions figured from contaminant dose limits over a maximum of 1,000 years. If scientists are not confident in the proposed boundary, the data gathering and analysis process resumes.

NTS Status

The UGTA Project has completed the Regional Model Phase of its groundwater investigations and has moved on to the individual test areas (Phase Two). UGTA specialists are in the process of collecting data from Frenchman Flat to improve confidence in the identification of the contaminant boundary and from Pahute Mesa to fill in data gaps. Scientists are sampling wells on Pahute Mesa to determine the location of contaminants and predict the movement of groundwater specifically between the NTS and Oasis Valley, as no such data currently exists. Samples taken from a series of eight wells installed at depths ranging from 2,000 to 5,000 feet should provide a detailed picture of the area's geology, information on the groundwater chemistry, and data describing the hydrogeological properties that control the direction and speed of groundwater movement. When the sampling phase is completed at Pahute Mesa, experts will create the localized geologic model and then move on to the groundwater flow and transport model.

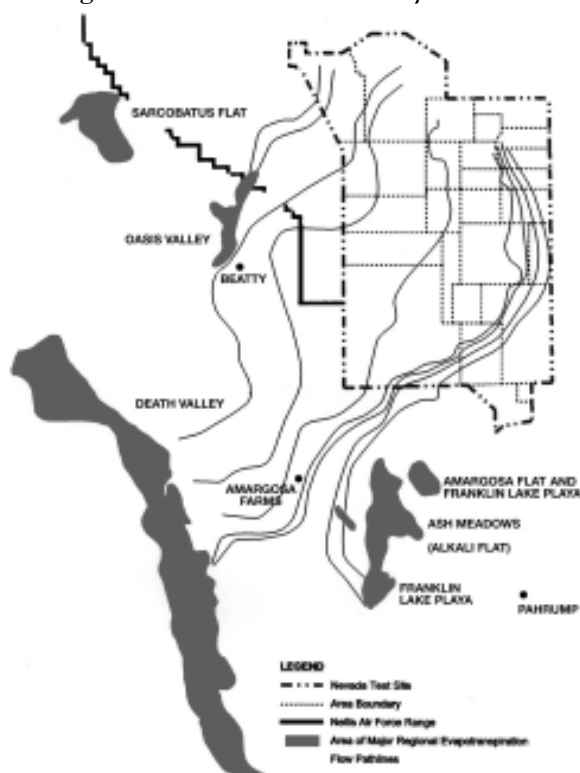
What's Next?

There are currently no proven, cost-effective methods for remediating deep, extensive groundwater contamination. Therefore, groundwater at NTS underground test areas cannot be remediated. As mentioned earlier, DOE/NV's main

objective is to develop an effective, long-term monitoring system which will serve as an early detection network to ensure the safety of off-site populations. Computer modeling will help groundwater specialists position monitoring wells more efficiently along this network.

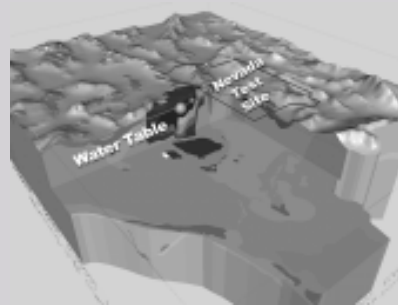
In order to complete these flow and transport models, DOE/NV will continue sampling and characterizing the CAUs until the year 2010. After modeling each CAU, the UGTA Project will engage in a five year "proof of concept" period to confirm the validity of the models' predictions regarding the behavior of the groundwater system and the movement of contaminants. If the results are acceptable to both DOE and the State of Nevada, DOE/NV will officially close these areas and establish the long-term monitoring program utilizing existing wells and, if necessary, installing new wells.

Regional Groundwater Paths from NTS



Computer Modeling

Computer modeling predictions will be the primary basis for determining contaminant boundaries and well placements for the monitoring network at the NTS. Over the past ten years, scientists have used this modeling technology to offer explanations on how groundwater systems at the NTS behave. These models are useful tools as they are able to integrate various forms of raw data, ultimately producing three-dimensional representations of the subsurface environment.





Meanwhile, in areas surrounding the Nevada Test Site, the U.S. Environmental Protection Agency (or another designated agency) will continue to monitor approximately 40 existing water supplies. To date, this detection network has shown no evidence of off-site contamination caused by underground nuclear tests.

Stewardship

The DOE/NV will establish institutional controls, including restricted access and use of groundwater, for the areas associated with the UGTA Project. For the foreseeable future, DOE/NV Defense Programs will serve as the steward of the NTS.

Public Involvement

Throughout the research process, DOE/NV has demonstrated a strong commitment to keeping local citizens informed about UGTA project activities and all relevant scientific findings. In an effort to encourage an open dialogue with stakeholders, UGTA representatives have visited rural communities located near study areas to discuss research strategies and solicit input regarding future actions. By arranging special field tours, UGTA has given various groups and media representatives the opportunity to see, first-hand, the data gathering process. If the public is interested in reading more about groundwater at the NTS, DOE/NV makes UGTA-related documents available through the DOE/NV Public Reading Facility at 2621 Losee Road, Building B-3, North Las Vegas, NV, or by calling (702) 295-1628. For more information and/or to comment on a groundwater-related issue, you can contact DOE/NV using the information below.

In the Field

Those charged with accomplishing the safe and timely construction of monitoring wells at the NTS are faced with a variety of difficulties. Sampling at such great



depths, for example, requires that technicians use special materials and methods to avoid compromising the water quality. Drilling operations are sometimes slowed when workers encounter unexpected geological impediments or borehole cave-ins. Further time and resources are invested to protect worker safety at well sites such as these because of the possibility of radiological contamination.

Despite the demands of such fieldwork, the UGTA Project has managed to stay ahead of its rigorous drilling schedule and has experienced no serious injuries to personnel.

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